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(19)

(54) DIGITAL MEMORY COIN TESTING METHOD AND APPARATUS

(71) We, MARS, INCORPORATED, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 1651 Old Meadow Road, McLean, Virginia, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention concerns a method and apparatus for coin testing and is a modification of the invention disclosed in the specification of our patent number 1,452,740.

The device disclosed in the aforementioned patent specification provides an indication of the validity of a coin by examining the coin and producing signals related to its individual characteristics, and then comparing the signals with reference values stored in a programmable memory. To program the reference values into the memory prior to coin testing, the device is put into a setting up mode of operation and the memory is then programmed by signals resulting from one or more reference coins undergoing the same examination as for coins being tested. The device therefore requires special programming circuitry for the setting up operation, which is not used in the normal testing mode of operation when the device is used for coin testing.

The present invention overcomes the need for memory programming circuitry in the device.

According to the present invention in one aspect there is provided a method of testing a coin for authenticity, including the steps of examining the coin and thereby producing an electrical signal having a value indicative of a characteristic of the coin, comparing the value with a reference value of values stored in a pre-programmed memory to determine whether it corresponds to a value for an acceptable coin, and producing a signal indicative of the acceptability of the coin with respect to the characteristic if the value is an acceptable value, the pre-programmed memory being selected prior to coin testing from a range of pre-programmed memories storing a range of reference values, the selection operation including subjecting one or more reference coins to the same examination as for coins being tested and thereby producing electrical signals having a value indicative of the said characteristic for the reference coins, and selecting a pre-programmed memory according to the value of the electrical signals, which memory is then incorporated in the device. The signal indicative of acceptability may also indicate the denomination of the coin. It is often desirable to conduct two or more examinations of different characteristics of a coin and accept the coin only if all of the examinations indicate that the coin is a genuine coin of the same denomination, a matter which is discussed, for example, in U.K. Patent No. 1,397,083. Plural examinations are similarly desirable according to the method of the present invention.

A reference coin may be a specially manufactured coin replica, or a coin which has been selected to produce a reference value signal for the examination being conducted. By the use of such reference coins, the appropriate memory can be selected from a range of pre-programmed memories. The memories may be mask programmed integrated circuit memories which are programmed during manufacture. A preferred selection operation includes subjecting a reference coin to the same examintion as the coin to be tested and producing electrical signals having a value indicative of one or more characteristics of the coin. The electrical signals are then tapped off from a suitable point in the circuit, and used to provide an indication of which memory to select from the available range. The values of the signals tapped off may be read by means of some form of display or counter. The range of memories

may be classified according to the reference values they store and to correspond with the values read from the counter or display.

One type of information which may be advantageously stored in the memory as reference values is the limit values, such as maximum and minimum frequency from a variable frequency output coin examining station. Another variation of our method is to store only one reference value for each denomination and then apply appropriate tolerances to that value in conducting coin examinations.

In many methods of coin examination the characteristic being examined and the means of examination produce a varying output during the examination period. In such methods it is often only a positive or negative peak variance of the examination means output which is representative of the characteristic being examined. According to the preferred method of our invention, in such cases we employ the further step of determining the peak variance value, for example by periodically sampling the output of the examination means and selecting the peak variance value which occurs during the examination periods. This technique may be used in producing the value which is to be compared to the values in the memory in the steps of examining a coin. This method can be used for example, with the variable frequency output of an inductor sensing station such as the inductors in Figure 8 of U.K. Patent No. 1,397,083. It can also be used, for example, with the digitised analog output of other types of sensing stations, such as an inductance bridge or a phase shift sensing station.

According to the present invention in a second aspect there is provided an apparatus for testing coins for authenticity comprising means for examining one or more characteristic of a coin and producing an electrical signal having a value representative of a characteristic of the coin, a pre-programmed memory, means for comparing a value of the electrical signal with one or more reference values stored in the pre-programmed memory, and producing a signal indicative of acceptability with respect to the characteristic if the value of the electrical signal is an acceptable value, and means for providing an indication of the values of the electrical signals produced when one or more reference coins undergo the same examination as for coins to be tested, whereby the pre-programmed memory can be selected according to the values of the electrical signals.

In the drawings,

Figure 1 is a schematic block diagram of an embodiment of the invention, and

Figure 2 is a schematic block diagram of another embodiment of the invention,

Throughout this specification the term "coin" is intended to mean genuine coins, tokens, counterfeit coins, slugs, washers, and any other item which may be used by persons in an attempt to use coin-operated devices.

The apparatus 10 of one embodiment of our invention, shown schematically in Figure 1, includes a sensor 20 adjacent a coin holder or coin passageway 30 for a coin 15, coin examining station circuitry 40 associated with the sensor 20 if such circuitry is used with the particular type of sensor, a pre-programmed memory 50 and a comparator 60. The apparatus 10 also includes means for causing the sensed value to be compared with the value stored in the memory 50, such as examination control circuit 70 and switching means 80, and a counter 90 for indicating the value of the electrical signals produced when a coin is examined.

The sensor 20, and the coin holder or coin passageway 30 are arranged with respect to the coin being tested according to known techniques, such as are described in the above-identified application. The apparatus is connected so that the value of a signal from the coin examining station circuit 40, if one is used, or from the sensor 20 itself, otherwise, is compared with a value stored in the memory 50 whenever a switching means, such as switching means 80, is activated to pass the one of the values to the comparison means 60. In this case switching means 80 is shown as controlling the flow of the sensor value to the comparison means 60. Alternatively, a switching means could be placed between the memory 50 and the comparator 60, or a switching means could be located in both inputs to the comparator 60. The switching means 80 is controlled by the examination control circuit 70 to ensure that the comparison is made at the appropriate time. The control circuit 70 may be activated by any of a number of means including a direct signal from the sensor 20, a signal from the coin examining station circuit 40 or from a separate coin presence sensor (not shown). One type of circuit which might be used is a peak picker, such as the ones described in our Patent No. 1,452,740.

The memory 50 is selected from a range of pre-programmed memories by a selection procedure including subjecting one or more reference coins to examination by sensor 20 and producing electrical signals related to one or more of its characteristics, tapping off the signals at a suitable point in the electrical circuit and passing the signals to the counter 90 to provide an indication of

their value. The memory is then selected according to the values read from the counter.

A single reference coin may be used to generate a single count in the counter and the memory pre-programmed with a single reference value closest to the value in the counter is selected from a range of memories pre-programmed with a single reference value. The comparator would then be arranged in use to compare the value of the coin under test with the single value in the memory and give an acceptability indicating signal if the value is within a predetermined tolerance, set by the comparator, of the reference value.

Preferably however the memory is pre-programmed with two values representing the upper and lower limits of the signal for an acceptable coin of a particular denomination and the comparator is arranged to provide the acceptability indicating signal if the value of the signal from the coin under test lies between the two values in the memory. The pre-programmed memory may be selected either by using a standard coin to produce a single count and selecting a memory programmed with values above and below the count in the counter, or by using two reference coins which represent the upper and lower values of the characteristic being tested, producing two counts from the two coins, and selecting the memory which has its two pre-programmed values closest to the two values of the count.

Apparatus 10 can be implemented with digital hardware or with a combination of analog and digital hardware as is appropriate for the type of coin examination and sensors employed, and the accuracy required and available with current technology. At present, we prefer to implement the apparatus 10 with primarily digital hardware, converting the signal from any analog-output sensor which may be used to a digital signal in the coin examining station circuit 40. Switching means 80 may then be an AND gate or the equivalent, and the comparator 60 may be a digital comparator such as employed in the peak picker 301 described in our Patent No. 1,452,740.

If analog implementation is employed with a digital memory, the output of the memory 50 is converted to an analog signal, for example, by a converter which is part of the comparator 60. The comparator 60 includes conventional analog comparator circuits. The comparator 60 would, in this case, also include an analog to digital converter.

The apparatus 210 of Figure 2 employs many elements similar to those of the apparatus 10 of Figure 1. The coin sensor 220, coin holder or psassageway 230 for a coin 215, the coin examining station 240, the memory 250 and the comparator 260 perform the same basic functions as the corresponding elements of the apparatus 10 of Figure 1. The memory 250 is selected from a range of pre-programmed memories by a selection procedure including subjecting one or more reference coins to examination by the senor 220 and producing electrical signals related to one or more of its characteristics, tapping off the signals from the output of the peak picker 275 and passing the signals to the counter 290 to provide an indication of their value. The memory is then selected according to the values read from the counter.

During the examination of coins, the output of the peak picker 275 can be connected to the comparator 260 to compare that output with the contents of the memory 250. In the event that the output of the peak picker 275 produces a value between the limit values stored in the memory 250 for genuine coins of an acceptable denomination, the comparator 260 will produce a signal indicative of the tentative identification of the coin being tested as a coin of that denomination. Alternatively, a memory system which includes a maximum value identification system, as described in our Patent No. 1,452,740, may be used during examination of coins and a separate peak picker is not required at such times.

As in the case of the apparatus 10 of Figure 1, the apparatus 210 can be implemented with substantially all digital circuitry or with a combination of analog and digital circuitry.

WHAT WE CLAIM IS:—

1. A method of testing a coin for authenticity, including the steps of examining the coin and thereby producing an electrical signal having a value indicative of a characteristic of the coin, comparing the value with a reference value or values stored in a pre-programmed memory to determine whether it corresponds to a value for an acceptable coin, and producing a signal indicative of the acceptability of the coin with respect to the characteristic if the value is an acceptable value, the pre-programmed memory being selected from a range of pre-programmed memories having a range of reference values, the selection operation including subjecting one or more reference coins to the same examination as the coin being tested and thereby producing electrical signals having a value indicative of the said characteristic for the reference coins, and selecting a pre-programmed memory according to the value of the electrical signals which memory is then incorporated in the device.

2. A method according to claim 1 in which a single reference value is stored in the

memory for each acceptable denomination of coin and the selection of the pre-programmed memory includes subjecting one reference coin of each denomination to the examination and selecting the memory from the range of memories that has a value most closely corresponding to the value of the signals produced by the reference coin, the value of the signal for a coin under test being compared with the reference value for each denomination of coin stored in the memory and the acceptability indicating signal being produced if the value is within a predetermined tolerance of the reference value for an acceptable coin.

3. A method according to claim 1 in which two reference values are stored in the memory for each acceptable denomination of coin, the reference values being representative of the upper and lower limit values of the signal for acceptable coins of that denomination, the value of the signal for the coin being tested being compared with the two reference values for each coin and the accepability indicating signal being produced if the value is between the reference values for an acceptable denomination of coin.

4. A method according to claim 3 in which the pre-programmed memory is selected by subjecting two reference coins of each denomination, representative of the upper and lower values of the characteristic, to the examination, and selecting from the range of memories the memory with values closest to the values of the signals produced for each reference coin.

5. A method according to any of claims 1 to 4 wherein the coin is examined by subjecting it to an electromagnetic field, the value of the electrical signal is indicative of the interaction of the coin with the field.

6. A method according to claim 5 wherein the interaction is indicated by the frequency of an oscillator which is a part of the means generating the electromagnetic field.

7. A method according to claim 6 wherein the frequency is determined by pulse counting for a finite, brief period to produce the values which are compared with values stored in the pre-programmed memory.

8. A method according to any of claims 1 to 7 further including the step of producing a signal indicative of the denomination of the coin if it is found to be acceptable.

9. A method according to any of claims 1 to 8 further including the steps of examining the coin and thereby producing a second electrical signal having a value indicative of a second characteristic of the coin, comparing the value of the second signal with a second reference value or set of reference values in the pre-programmed memory, to determine whether it corresponds to the value of an acceptable coin, and producing a signal indicative of the acceptability of the coin with respect to the second characteristic when the value of the second signal is acceptable, the pre-programmed memory having been selected prior to examining the said coin by subjecting one or more reference coins to the same examination as the coin being tested and thereby producing electrical signals having a value indicative of the said second characteristic for the reference coins, and selecting the memory from a range of memories that has values most closely corresponding to the values of the signals.

10. A method according to claim 9 in which two reference values of the second signal are stored in the memory for each acceptable denomination of coin, the reference values being representative of the upper and lower limit values of the second signal for acceptable coins of that denomination, the value of the second signal for the coin being tested being compared with the two reference values for each coin and the acceptability indicating signal for the second characteristic being produced if the value is between the reference values for an acceptable denomination of coin.

11. A method according to claim 10 in which the pre-programmed memory is selected by subjecting two reference coins of each denomination, representative of the upper and lower values of the second characteristic, to the examination, and selecting the memory from a range of memories that has values most closely corresponding to the values of the signals produced for each reference coin.

12. A method according to any of claims 9, 10 or 11 wherein the examination with respect to the first characteristic is dependent upon the interaction of the coin with a relatively high frequency field and the examination of the second characteristic of the coin is dependent upon the interaction of the coin with a substantially lower frequency field.

13. A method according to any of claims 1 to 12 in which the coin is caused to move through to a position at which it is examined, and in which the production of the acceptability indicative signal with respect to the first characteristic is dependent upon whether the peak variance of the first value corresponds to an acceptable value.

14. A method according to any of claims 1 to 13 in which the electrical signal is in analog form at a coin examining station and the value of that electrical signal is converted to digital form prior to comparison with the values stored in the pre-programmed memory.

15. An apparatus for testing coins for authenticity comprising means for

examining one or more characteristics of a coin and producing an electrical signal having a value representative of a characteristic of the coin, a pre-programmed memory, means for comparing a value of the electrical signal with one or more reference values stored in the pre-programmed memory, and producing a signal indicative of acceptability with respect to the characteristic if the value of the electrical signal is an acceptable value, and means for providing an indication of the values of the electrical signals produced when one or more reference coins undergo the same examination as for coins to be tested, whereby the pre-programmed memory can be selected according to the values of the electrical signals.

16. An apparatus according to claim 15 in which the pre-programmed memory stores a single reference value for each acceptable denomination of coin and the comparing means produce the acceptability indicating signal if the value of the electrical signal is within a predetermined tolerance of a reference value.

17. An apparatus according to claim 15 wherein the reference values stored in the pre-programmed memory include the upper and lower limit values for coins of each acceptable denomination and the comparing means produce the acceptability indicating signal if the value of the electrical signal is between the upper and lower limit values for a coin of an acceptable denomination.

18. An apparatus according to any of claims 15 to 17 including a coin passageway and means for producing an electromagnetic field in a region of the passageway, wherein the first value is indicative of the degree of interaction of coins with the field.

19. An apparatus according to claim 18 wherein the field producing means includes an oscillator and the first value is dependent on the oscillator's frequency.

20. An apparatus according to any of claims 15 to 19 further comprising means for indicating the denomination of acceptable coins.

21. An apparatus according to any of claims 15 to 20 further comprising means for examining a second characteristic of the coin and producing a second electrical signal having a value representative of the second characteristic, means for comparing a second value of the second signal with one or more values stored in the pre-programmed memory, and means for producing a signal indicative of acceptability of the coin only if the comparisons of the first value and of the second value both indicate the the respective values correspond to acceptable values for a coin of a given denomination.

22. An apparatus according to any of claims 15 to 21 wherein the acceptability of the coin with respect to the first characteristic is dependent upon whether the peak variance of the first value is an acceptable value.

23. An apparatus according to claim 14 or 22 further comprising a coin passageway, means comprising an oscillator and an inductor for generating a relatively low frequency electromagnetic field in a region of the passageway, means comprising an oscillator and an inductor for generating a substantially higher frequency electromagnetic field in a region of the passageway, wherein the value of the first electrical signal is dependent upon the frequency of the oscillator of the higher frequency field producing means.

24. An apparatus according to any of claims 15 to 23 further comprising analog to digital signal converting means connected to receive an analog signal from an examining means and transmit a digital signal to a comparison means.

25. An apparatus according to any of claims 15 to 24 including peak value identification means connected to receive and identify the peak value of the first electrical signal.

26. An apparatus according to claim 19 or 23 further comprising a pulse counter connected to receive the first signal and a timing means arranged to activate the pulse counter for precise, brief periods of time.

27. An apparatus according to claim 26 wherein the pulse counter is alternately connected to receive the first signal and a second signal.

28. An apparatus according to claim 26 further comprising means for comparing the value stored in the pulse counter at the end of a period of time with at least one value stored in the pre-programmed memory.

29. An apparatus according to claim 26 wherein the value in the pulse counter is compared during the period of counting with values stored in the pre-programmed memory.

30. An apparatus according to any of claims 15 to 27 wherein a plurality of limit reference values are stored at various addresses in the pre-programmed memory, further comprising an address register arranged so that its output selects the address in the pre-programmed memory which is connected to the comparison means, and the output of the comparison means transmits a signal to the address register which changes the address register output whenever a value received by the com-

parison means from the first characteristic examining means, is at least as large as the value in the address of the pre-programmed memory to which the comparison means is connected.

31. A method of examining coins, substantially as described hereinbefore with reference to the accompanying drawings.

32. Apparatus for examining coins, substantially as described hereinbefore with reference to the accompanying drawings.

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1527450 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

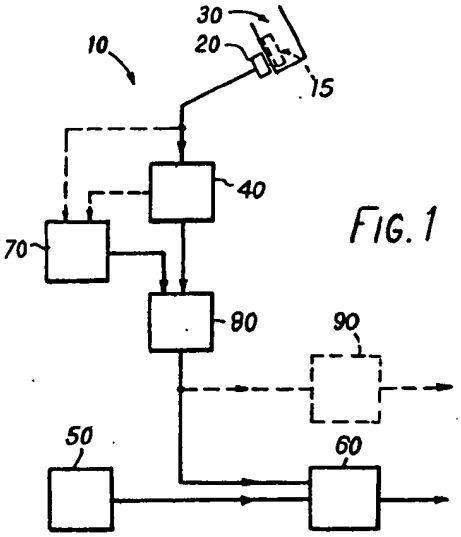

FIG. 1

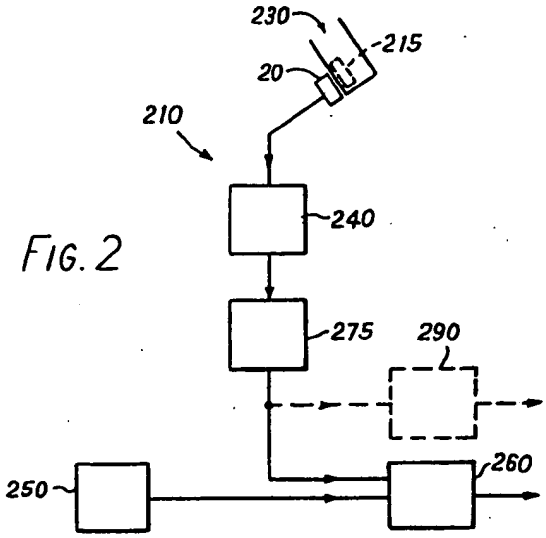

FIG. 2